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HYDROGRAPHIC OFFICE U.S. NAVY

# REPORT

OF THE

# INTERNATIONAL METEOROLOGIC CONGRESS

AT

PARIS, FRANCE, SEPTEMBER 19–26, 1889.

BY

LIEUTENANT AARON WARD, U. S. N.,

UNDER THE DIRECTION OF

CAPTAIN HENRY F. PICKING, U. S. N.,
HYDROGRAPHER.

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HARVARD COLLEGE
JUL 5 1890

Capt. Henry F. Picking,
U.S.N.

# INTRODUCTION.

This report by Lieutenant Ward of the proceedings of the International Meteorologic Congress at Paris, in September, 1889, will, it is thought, be of general interest, although its publication has been unavoidably delayed. This office was honored by the committee on organization with a request to send a delegate, and upon the Hydrographer's recommendation the Honorable Secretary of the Navy delegated Lieutenant Ward, then naval attaché at the United States legation, Paris, to represent the office. Although it has been impracticable to publish in full the copious appendices accompanying the report itself, yet this abstract of the daily proceedings must be of value, and it well illustrates the intelligence, thoroughness, and care with which the Congress discussed the various important subjects that were brought before it.

This office is heartily in favor of more effective co-operation between the various offices that are working in marine meteorologic research, and it is interesting to note the strong support given by this congress to this matter. Attention has also been called to the fact that an international system of simultaneous observation might well be arranged in order to chart and discuss data for the southern hemisphere, as has been done already for the northern, and this is a subject in which navigators are especially interested. It must, I think, be acknowledged that the general results of such international congresses are very good, and it is gratifying to know that this office was represented, and represented so well, upon this occasion.

HENRY F. PICKING,
*Captain, U. S. N., Hydrographer.*

WASHINGTON, D. C., *May* 14, 1890.

# REPORT ON THE INTERNATIONAL METEOROLOGIC CONGRESS

## HELD AT PARIS, FRANCE, SEPTEMBER 19-26, 1889.

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This Congress, convoked under the auspices of the French Minister of Public Instruction by the Committee of Organization of the Paris Universal Exposition of 1889, assembled at the Trocadéro September 19.

The Congress was called to order at 3 p. m. by M. Mascart, director of the Bureau Central Météorologique, as a representative of the Minister of Public Instruction. On behalf of that Minister, M. Mascart extended a cordial welcome to the members of the Congress and especially to the foreign members who had accepted the invitation to attend this reunion. He expressed his gratification that the Congress owed its origin in great part to a recognized authority among meteorologists, namely, M. Renou, president of the Meteorologic Society of France, who has devoted his life to this class of work and who is renowned for his efforts towards the introduction of precise methods of observation in meteorology.

In the name of the Minister of Public Instruction, M. **Mascart** expressed the hope that the work of the Congress would materially advance the interests of meteorology.

Mr. **Symons**, in behalf of the foreign meteorologists, recalled also the valuable work of M. Renou and nominated him as president of the Congress. The nomination, duly seconded, was unanimously carried.

Monsieur **Renou**, on taking the chair, submitted to the Congress a list of vice-presidents and others, as follows:

*Vice-Presidents.*—Messrs. Symons (England), Denza (Italy), Hildebrandsson (Sweden), Paulsen (Denmark), Billwiller (Switzerland), Pujazon (Spain), Gould (Argentine Republic), Cruls (Brazil).

*General Secretary.*—M. Teisserenc de Bort.

*Secretaries.*—MM. Moureaux, Lasne, l'Abbé Maze, Lancaster.

The Reverend Father **Denza** paid a tribute to the valuable work of French meteorologists and assured the Congress of the cordial co-operation of the foreign members.

The **President** recalled the good results of the Congress organized by the Meteorologic Society in 1878:

> The Congress inaugurated to-day will also lead to important results, for a frequent exchange of ideas is necessary in most sciences and indispensable in meteorology.

In spite of the important advances made through the efforts of the International Meteorologic Commission, many questions are still open to the consideration of the present Congress; selection and placing of instruments, methods of observation, notation of phenomena, extension of the net-work of observation stations, a greater application of telegraphic facilities to the transmission of meteorologic data, increased rapidity of publication of results, etc.. In the last connection the President paid an eloquent tribute to the work done by the State of Ohio, United States of America, and referred especially to the promptness with which the monthly reports were printed and made accessible to the general public.

The PRESIDENT expressed the hope, in conclusion, that he might count upon the generous support of all the members present toward assuring a bright future for the science of meteorology.

A program of sessions and of hours of meeting was thereupon adopted.

M. MASCART laid before the Congress a specimen copy of international meteorologic tables, published under the auspices of the international committee in accordance with resolutions adopted at the Congress of Rome. This publication has been superintended by two members of that committee, Messrs. Mascart and Wild. The introduction and captions of the tables are in three languages—French, English, and German. The universal adoption of these tables would be a new step forward in generalizing the use of the metric system. The subscriptions already secured cover the expenses of the volume and the books will be ready for distribution by the end of the current year.

The Congress hereupon adjourned, to meet Friday, September 20, at 9 a. m.

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FRIDAY, *September* 20, 1889.

Mr. A. PAULSEN in the chair.

The Congress assembled at 9 a. m., pursuant to adjournment, and the secretary read the record of the previous day, which was approved.

M. HILDEBRANDSSON (Sweden) communicated to the Congress a memoir on the classification of clouds. The classification adopted proposes ten form-names, as follows:

| | | | |
|---|---|---|---|
| Cirrus | 1 | | |
| Cirro-cumulus | 2 | Cirro-stratus. | |
| Cumulo-cirrus<br>or<br>Alto-cumulus | 3 | Strato-cirrus<br>or<br>Alto-stratus | General circulation clouds. |
| Strato-cumulus | 4 | Nimbus. | Do. |
| Cumulus | 5 | Cumulo-nimbus, ascending current. | |

Stratus: Fog—more or less elevated.

M. **Hildebrandsson** presented in connection with his paper a series of photographs taken at his observatory and a set of oil paintings prepared partly in Sweden and partly at Hamburg, to illustrate his proposed classification. The paintings it is proposed to reproduce by chromo-lithography under the direction of MM. Hildebrandsson, Neumeyer, and Köppen.

M. **Mascart** congratulated the lecturer and dwelt upon the importance of the work; hoped that the publication of the colored illustrations would be successful, as it would be of signal advantage to meteorology to have a uniform nomenclature for clouds.

M. **Doumé** noted that in this classification one important form has not been included, viz, the cumulus broken up and driven by a violent wind (the mistral). This form is important in the Mediterranean. The speaker proposed to name it the *fracto-cumulus.*

M. **Hildebrandsson** replied that he had only sought to give general lines of classification applicable everywhere. He said that it was always easy to distinguish at any given observatory by a special name any local form of cloud which may have real importance at that place.

M. l'Abbé **Maze** stated that he had prepared a memoir on the same subject, to be read later; he would anticipate it by saying that his classification differed but little in principle from that of M. Hildebrandsson. In his nomenclature, however, he proposed a binary form, to avoid the difficulty suggested by M. Doumé; the first word of the former to indicate the class of cloud (of which he proposes some ten or eleven), and the last word to define the particular species in the class.

M. **Doumé** approved of the nomenclature of M. l'Abbé Maze as very advantageous; it would avoid the confusion which might arise from improper use of such proposed terms as strato-cirrus and cirro-stratus to indicate totally different kinds of clouds.

M. l'Abbé **Denza** reverted to the suggestions of M. Mascart, which he approved. The distribution to observatories of the instructions of M. Hildebrandsson would be of the highest usefulness. It is difficult to make names comprehensible by descriptions only, especially to observers at minor stations, and the chomo-lithographs will be an absolute necessity.

M. **Hildebrandsson** stated that his classification had been adopted at the Congress of Melbourne for the stations of Australia and New Zealand. Mr. Ellery had asked for one hundred copies of the work.

M. **Teisserenc de Bort** insisted upon the confusion which may arise between the cumulus with broken edges mentioned by M. Doumé and the nimbus of the Hildebrandsson system. This form of broken cumulus is frequent in Algeria and the desert of Sahara and of real importance to Mediterranean navigators.

M. **Doumé** added that this variety has its origin in cumulo-nimbus clouds. He went to observe the formation of the fracto-cumulus from the crest of the Cevennes and of the Montagne Noire. The clouds come up from the ocean in compact masses of cumulo-nimbus, with light rain-fall. Above the crest-line these cloud masses are dispersed under the influence of northwest winds and descend into the Mediterranean basin in the form of fracto-cumulus clouds which no longer reform as cumulus.

Mr. **Symons** expressed the opinion that a proposal should be made during the Congress to open a subscription for finishing the work of Mr. Hildebrandsson. He promised the assistance of the British Meteorological Society and believed that other nationalities represented would co-operate.

Mr. **Ritter** postponed to a later session a report on a more simple classification prepared by him.

Rev. Father **Denza** read a paper on the "Decrease of temperature in the vertical line." His numerous figures may be summed up as follows: The annual mean ascent required to obtain a decrease of 1° in temperature was:

| | Meters. |
|---|---|
| In the valley of Aosta | 159 |
| At Moncalieri (Mt. Cenis) | 191 |
| Mean for the whole of Italy | 192 |

In spite of the agreement of the last series of figures, R. P. Denza is more disposed to accept as correct the figures for the valley of Aosta, a decision which he bases in part upon the statement in United States reports. In these it is shown that at Pike's Peak, Colorado, the mean annual increase in height for 1° decrease of temperature was 159 meters and for the winter 185 meters. For the winter the heights required in Italy were:

| | Meters. |
|---|---|
| Valley of Aosta | 189 |
| Moncalieri | 375 |
| Mean for the whole of Italy | 289 |

showing the values for the valley of Aosta to agree closely with the United States authorities, both for annual average and for the winter season.

It happens not unfrequently that the temperature will rise with the ascent up to a certain height and then decrease on further elevation. This effect is far more marked in winter and has never been recorded in a more remarkable way than in January, 1887.

The following were the results obtained:

| Station at elevation of— | Temperature. |
|---|---|
| *Meters.* | ° |
| 272 | −14.8 |
| 365 | −12.9 |
| 439 | − 7.2 |
| 512 | − 6.4 |
| 686 | − 7.8 |
| 1,930 | −11.5 |

During this month the barometric pressure was high and the ground covered with snow; air dry; calm. The temperature increased up to 700 meters and then diminished, according to the ordinary law. The same fact was verified in other mountainous regions. The lecturer pointed out that the problem was obscure and complex for hilly regions and that numerous observations were yet needed.

M. **Thévenet** suggested that distinction be made between observations made in calm or in windy weather, and in the latter case as to whether the air-currents are ascending or descending the sides of the mountain.

R. **Père Ferrari** has observed that in the Roman Campagna the air heated by day on the plains rises at night along the mountain-sides, which may cause perturbations in the temperature readings for different altitudes.

M. **Guérard** said that in these observations it is necessary to take into account the force of wind at each station. Also, if the directions of the wind are different, the result of comparisons will be doubtful. Thus at the observatory of Nice a difference of 1°.6 has been observed from the temperature of the town when the wind was the same at both stations, and that is considered the normal difference. But when the wind differs at town and station the temperatures are very variable.

As another example he instanced his own ascent of Mont Marnier to the altitude of 2,818 meters. He observed at the base a temperature of 16°, and at the summit, with a change of altitude of 2,318 meters, a temperature of 31°, stiff south wind prevailing.

M. **Billwiller** noted that the diminution of temperatures is different for places even when near each other, and that the difference depends unquestionably upon the condition of the ground. In winter, when there is stagnation of the air, the temperature decreases in the valleys. It happens frequently in Switzerland that at an altitude of 500 meters the temperature is lower than at 2,000; at St. Moritz the temperature often falls to —30° when it is —20° at the stations in the Albula and Julier passes, higher up.

On the shores of Lake Constance the mean temperature is 1°.2 lower than that of a station 1,200 meters higher. The law depends, then, upon the manner in which the stations are selected, and you may get as many results as you have comparisons. Still, aside from the winter months the problem is simpler, for there is less stagnation and as soon as the air circulates the regular laws of temperature change are reestablished.

M. **Wada** (Japan) said that there exists near Tokio an extinct volcano 3,700 meters in height and well situated for observations, and that on the two occasions mentioned below he obtained the results given.

In August, 1882, during three consecutive days—observing only during the day—a mean difference of 20° was observed with a minimum of temperature of 9°.8 for a difference of level of 3,685 meters, which gives

0°.55 per 100 meters of ascent, or 182 meters of ascent for a change in temperature of 1°.

In August, 1887,—observing day and night—there was obtained for a difference of altitude of 3,695 meters a mean difference of temperature of 21°.9, with a minimum of 5°.7, which gives 0°.59 per 100 meters of ascent, or 168 meters of ascent for change of 1° in temperature.

The Rev. **PÈRE DECHEVRENS** pointed out the necessity of taking into account the barometric pressure when comparing changes of temperature in the vertical:

> By just as much as we observe high temperatures with an unusually high barometer, by just so much the low temperatures observed with a very low barometer will stand under the mean record for low temperature.

R. P. **DECHEVRENS** has verified this law for several mountains in Europe, Asia, and America. In China as soon as the pressure decreases the temperature rises. The observatory is situated on a mountain in the midst of a vast plain. No matter what the direction of the wind there is noted habitually a rise of 10° of temperature for a fall of 20 millimeters in barometric pressure. At Mount Washington, in the United States, the wind is habitually northwest and violent. It sometimes blow at the rate of 100 miles an hour. Under these conditions the temperature varies 30° for the above amount of decrease in barometric pressure.

M. **MASCART** doubts the above recorded force of the wind.

R. P. **DECHEVRENS** replies that he takes it from the record of the Signal Service, and Mr. Rotch confirms the indication.

M. A. **PAULSEN** communicates to the Congress the results of measures taken in Greenland on the elevation of the aurora borealis above the earth. The measures obtained in temperate regions have given an elevation of 200 kilometers or more, but it is not the same for polar latitudes. At the station at Gothaab he operated on a base 5,800 meters long. The two theodolites were fixed in a common vertical plane and observations were always taken of the lower edge of the aurora, which is the best defined.

It was found that at times the aurora descended to within 600 meters of the fiord which separated the two observers. Other auroræ, on the contrary, rose to 60 or 70 kilometers. It was decided to reject all observations giving a parallax of less than 1° as being uncertain.

The above proves that the height of auroræ being so variable there is no mean atmospheric layer or stratum in which they form rather than in another.

M. **PAULSEN** gave a monthly table of the auroræ observed at the two stations of Gothaab and Ivigtut; also a table of the number of auroræ by periods of three years each—from 1865, at same stations. It results from suitable comparisons that the maximum frequency of auroræ corresponds with the minimum of solar activity, which is precisely contrary to what obtains in temperate zones.

Finally, M. **Paulsen** compared these phenomena with the variation in amplitude of the magnetic needle.

In temperate zones the amplitude of diurnal motion of the magnetic needle increases with the number of spots on the sun. It is absolutely the contrary, according to the essayist, in polar regions; so that the coincidence of frequency of auroræ with increase in motion of needle holds good for all latitudes.

M. **Mascart** notes the interest of establishing close relations between the polar auroræ and magnetic phenomena. But he asks that observers note particularly the perturbations of the needle during the whole day of the aurora, as well as during its appearance.

M. **Teisserenc de Bort** presented a memoir by M. Seratzky on the luminous clouds of 1885–'86 at Moscow. This phenomenon began about June 4. 1885. On June 24 an unsuccessful effort was made to measure the cloud heights (base too short); on June 26 the experiment was renewed with success, giving an altitude of 75 kilometers.

These clouds were only observable when the sun was down and at a certain angle below the horizon; they were therefore not of the "phosphorescent cloud" type, but owe their light to the sun. They were absolutely transparent, stars of the smallest magnitude being visible through them. Their intensity has decreased progressively, and in 1888 they disappeared altogether.

The point was noted that the first appearance of these clouds coincided with the colored twilights reported by Mr. Symonds as due to the volcanic eruption at Krakatao.

Photographs taken of these clouds showed very fine striae, like delicate cirrus clouds, but quite invisible to the naked eye.

At noon the Congress adjourned to meet Saturday, September 21, at 9 a. m.

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SATURDAY, *September* 21, 1889.

Rev. **Père Denza** in the chair.

The Congress met at 9 a. m., and the record of the previous day being read and approved—

M. **Teisserenc de Bort** announced the presence of M. le Commandant Renard, delegate of the Minister of War, M. de Secgny, delegate of the Minister of Marine, and M. Poincavré Phillipe, delegate of the Minister of Agriculture.

M. **Angot** presents the results of observations of the force of the wind taken at the summit of the Eiffel tower and simultaneously on the small tower of the Bureau Central Météorologique.

Until August 31 there were seventy-one days of complete observations, giving for the diurnal variation of the force of the wind the following results:

At both stations, apart from some secondary undulations, the diurnal curve of force shows one maximum and one minimum. At the Bureau Météorologique the minimum (1.57 per second) occurs at about 4 30 a. m. and the maximum (3 per second) about 1 p. m., which is the usual result for low stations.

On the summit of the Eiffel tower, on the contrary, the minimum (4.9 meters per second) occurs a little before 9 a. m. and the maximum (8 meters per second) takes place about 11.30 p. m., which is the kind of curve characteristic of mountain stations.

The ratio between the force of the wind at the two stations is maximum and equal to 5 at between 2 and 4 a. m., and minimum, which is equal to 2, between 9 a. m. and 3 p. m. It is very interesting and altogether unexpected to find at only 300 meters above the ground a diurnal curve of wind force which has hitherto been noted only at high mountain stations.

M. ANGOT adds that he will not dwell upon the vertical component on account of the difficulties of the question; among these difficulties he notes that it suffices for a horizontal air current to strike the anemometer cups unequally to produce motion and lead to the mistaken idea of a vertical component.

The Rev. PÈRE DECHEVRENS notes that this is a defect common to all rotating anemometers.

M. ANGOT agrees, but considers the defect of chief importance when it is attempted to study the vertical component.

M. HÉPITÈS (Roumania) having read an interesting paper on the meteorologic stations of that country—

The PRESIDENT thanks him in behalf of the Congress for having, chiefly by his individual exertions, filled a gap that existed in the network of European meteorologic stations.

M. MASCART expresses the hope that such natural phenomena as the phases of vegetation, migration of birds, etc., be studied in Roumania in connection with the weather service. These records, of which M. Hildebrandsson among others has given us such a splendid model, would have a special interest coming from Roumania, on account of the wide variations in its extreme climate (for Europe.)

M. HÉPITÈS replies that the Meteorological Society of Roumania has already commenced this work.

Rev. PÈRE DENZA presents seventeen tables calculated by Professor Paul Busia, member of the Meteorological Society of Italy, giving mean monthly and annual temperatures for three hundred and thirty-eight Italian stations. Rev. Père Denza draws from these tables some general conclusions. The valley of the Po has in winter a central cold point, in Piedmont and lower Lombardy; from this center as a radius the winter temperatures are higher. When the spring approaches, the relative coldness of this center decreases and disappears between April and May. It is succeeded in due time by a center of heat in the same valley—etween Lombardy and Romagnes—which is most marked in July.

Similar centers are found in the other valleys. On the plains and in the low ranges of hills on the Adriatic coast the mean temperatures are lower in winter and higher in summer than those observed at similar points on the Mediterranean side. The temperatures of the coast stations are notably higher in winter and lower in summer than in the interior, and less so on the Mediterranean coast than on the Adriatic.

The lake regions enjoy in winter notably mild temperatures. From this the Rev. PÈRE DENZA concludes the impossibility of establishing formulæ which will represent the mean temperatures of Italy by taking as a principal factor the difference of latitude. For particulars the Rev. PÈRE DENZA refers the members of the Congress to a work about to be published in the Monthly Bulletin of the Italian Meteorologic Society.

M. SIEUR presents a communication on the secular changes of climate. He seeks to refute the arguments of certain astronomers which tend to explain the variations of temperature by the displacements of the perihelion. He quotes a certain number of instances where the thermic mean is in absolute contradiction to the astronomic theories. He insists upon the distinction between a *severe* and a *long* winter. He ends by comparing the thermometric means of 1740 and 1888 for the Paris station. These two years have the same mean, whereas according to the astronomical theories the mean of 1888 should be inferior.

M. RENOU remarks that the figures given by Réaumur for the winter of 1740 are certainly in error. During that winter the vine froze, which requires a cold very much greater than that indicated by Réaumur, whose minima, compared with the cold of the French plains, must be in error by many degrees. M. Renou recalls, to justify this statement, that Réaumur's station was in the midst of a populous city and that he (Renou) in 1872 found a difference of temperature between the garden of the school of medicine at Paris and the plain of Aubervilliers of 10°.

M. HILDEBRANDSSON has studied the changes of temperature for several centuries and can find no secular variations. The botanists have insisted that Sweden is getting colder and that vegetation is receding southward, because where there are now no forests there are evidences of previously existing ones. But later observations have shown that these forests are renewing their growth. The truth is that these forests grow for a certain number of years, then comes an excessive cold, which causes them to perish, and afterwards they grow anew.

The dates of freezing and thawing of the Russian lakes and rivers, recorded since the fifteenth century, lead to the same conclusion. The similar Swedish observations do not go back so far. While they confirm the Russian results, they have permitted us to notice a variation of more than a month, the warmest period being in 1740 and the minimum in 1812. In Linné's time the annual development of vegetable life was studied for ten years and the results, compared with the decade just past, give exactly the same records. Secular variations do not exist.

M. **Angot** says that the discussion of the period of vintage, kept on record since the thirteenth century, shows variations of temperature, but does not permit us to conclude the existence of a secular variation.

R. **Père Ferrari** says that the cooling of the sun could produce a cooling of the earth, but that the temperature of the sun is so high and its cooling so small that the effect measured on the earth could hardly be of sensible effect.

M. **Mascart** says that the receding movement southward of the vine has been often quoted as a proof of change. But it proves nothing. When the means of transportation were more restricted than to-day, people were content with wines of their own region, where the vine might give but one good vintage every decade; and that what they harvested at other times was perhaps as good as the artificial wines of to-day.

As to the glaciers, they prove nothing; for there are proofs that Greenland was colonized in the Middle Ages and that the name of *Green land* indicates vegetation. To-day that country is covered with ice, but while these glaciers extend down toward the south, the glaciers of the Alps are receding. The glacier is not the expression of an actual state of affairs, but the consequence of a previous condition. Moreover, it is not cold, but dampness, which determines the glacier formations. According to M. Dufour, the glacier has this origin and glaciers will advance and recede according as the previous years have been dry or damp.

R. P. **Denza** points out that the Alpine glaciers (Italian) have been advancing for the last three years.

M. **Mascart** notes that at the time when the glacier of the Bassons was advancing, the Mer de Glace was receding.

Mr. **Symons**, who has studied the thermal springs of the Pyrenees, finds no variation since the days of the Romans. The temperature found to-day for several springs agrees exactly with the observations of Arago.

M. **Renou** says that the variation of temperature of springs in the Carpathians proves nothing. Earthquakes may vary the delivery of springs; but the temperature of such springs is a function of their flow.

Mr. **Renou** then reads a note to close the discussion, which will be added later to the record.

M. **Piltchikoff** points out the loss of latent heat of the terrestrial globe. It is known that the loss of heat by radiation is very different according to the more or less cloudy state of sky. The variation of eccentricity of the globe, by changing the ratios of heat received by the earth in summer and in winter, will change the distribution of clouds. The heat transmitted from the sun to the globe will not compensate for the loss of the latter, for the emitting power of the two bodies is different. These changes will then cause a loss of the earth's heat.

M. **DUCHÈNE** notes the influence that may be caused by the destruction of forests.

M. **RENOU** considers that influence as *nil.* Man can not, in any way, influence the changes of climate.

M. **SYMONS** presents to the Congress a new instrument constructed for him and to which he gives the name of *brontometer.* It is a registering apparatus, permitting the notation of the precise moment of the apparition of lightning flashes, commencement and length of the thunder-clap, etc. The instrument also registers the smallest and most sudden variations of barometric pressure; force of wind; hour, length, and quantity of rain or snowfall. M. Richard is the constructor of this instrument.

M. **TEISSERENC DE BORT** presents, on behalf of M. Paul Garnier, some cloud photographs of very remarkable beauty.

Session closes at noon. Congress adjourns to meet Monday at 9 a. m.

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MONDAY, *September* 23, 1889.

Mr. **HILDEBRANDSSON** in the chair.

The record of the previous day having been read and approved,

Mr. **ROTCH** gave a description of the nephoscope in use at the observatory of Blue Hill, devised by Mr. Clayton, an assistant at that observatory. It gives the bearing and altitude of the cloud and its relative speed. The probable error in bearing is ± 2° for cirrus and ± 3° for cumulus.

Since the beginning of 1887 the quantity, bearing, and relative speed of clouds have been observed almost hourly from 7 a. m. to 11 p. m.; the results for 1887 and 1888 are published in Vol. XX of the Annals of the Observatory of Harvard College.

By means of a Campbell heliograph the percentage of possible insolation was obtained and the complement of these data gives the mean cloudiness per month and per year, 3 per cent. lower than that indicated by direct hourly observations taken during daylight.

To record the amount of clouds at night, an apparatus invented by Professor Pickering, director of Harvard University, was used. It consists of a camera fitted with sensitive plates and directed at the pole star. The obturator is closed automatically before daylight. If the night has been clear, the plate will show an arc of a circle traced by the motion of the star about the pole; if clouds have passed, the trace will be a dotted line. This gives the amount of time during which the star was visible, hourly, and its complement gives the amount of cloudiness, which differs less than one-tenth from the mean of direct observations.

M. **GEORGE LEMOINE** read a memoir on the progress made since 1878 in the principal river basins of France towards improving the service of predictions of floods.

The Government organization of a service of warnings has become general. A collection of rules has been published for the basins of the Garonne, Saône, and other rivers. In the valley of the Rhône, alone, there are still gaps in the chain of observing stations.

The observations of rain-fall have been much improved and efforts are being made to increase their number in the higher levels, especially on the lines of divides.

The *Commission d'Annonce des Crues* has completed its work by obtaining the publication, by regions, of observations on the water-courses. In the valley of the Seine this publication was commenced by M. Belgrand in 1854, and has been continued to the present time, covering the longest period of continuous observations. The technical studies required for prediction of floods have been carried out on different principles in the different valleys. Along the Meuse the predictions are still being made according to the rules established long since by M. Poincaré. On the Saône, M. Remise, by his method, has been able to predict floods successfully between Châlons and Macon four days in advance.

For the Seine, M. G. Lemoine and M. de Préandeau have grouped the principal numerical data in the Manual Hydrologique, published in 1884.

The completion of a system of dikes and walls at Paris, as aids to navigation, has changed the regular flow of the stream for that city (and places down stream), and made the regimen of the river artificial for mean and low water stages, but during high stages, the reserve-locks being opened, the regular flow of the stream is re-established.

M. LEMOINE mentions and discusses the recent works of Messrs. Allard, Mazoyer, and Harlacher. After many experiments, M. Lemoine seems to prefer the method of prediction adopted by M. Belgrand. It is based upon a comparison of rises—on variations of level of the water-courses—giving heed to the relative porosity of the ground in the different water-sheds and basins.

M. MASCART recalls the valuable assistance given by M. Lemoine to M. Belgrand and the part he has taken to improve the value of predictions of floods in France.

M. BOUQUET DE LA GRYE wishes to know if it would not be possible to publish a table showing amount of flow corresponding to given heights of water in a river.

M. LEMOINE says that such a table would be very difficult to prepare. The question asked by M. de la Grye has long occupied engineers. The relation between the flow and the height of water is given for the Seine at Mantes in the Hydrologic Manual for the valley of the Seine. The figures given there for 1856 have been confirmed by recent experiments, made in 1883.

M. TEISSERENC DE BORT proposes that the congress should vote a resolution for the increase in number of rain-recording stations in different countries.

M. MASCART approves the proposition.

M. ROULIN says that a resolution of that character is all the more necessary in France, as in certain basins it is recommended to reduce the number of observing stations, for reasons of economy.

M. TEISSERENC DE BORT thereupon submitted to the congress the following resolution, which was unanimously adopted:

> This congress expresses the hope that in every State the competent authorities will develop as much as possible the net-work of hydrometric stations, so as to permit of exhaustive studies on the relations between rain-fall and the mean and extreme rate of flow in water-courses.

M. RITTER submits a new method of scientific notation, applicable to meteorology and other branches. By it he substitutes for a number directly observed (indicating the absolute intensity of a phenomenon) a coefficient or "grad" (meteorograd, isobargrad, etc.) to represent relative intensity as compared with some standard, usually a mean. Applying this principle to the questions of rain-fall and of floods, M Ritter laid before the congress a number of charts prepared according to his method bearing upon these subjects. Also some diagrams, to show how the principle could be extended, for example, to isobaric charts, where he would substitute, for the present isobaric curves, what he calls *isobargrads*. By using these he would convey an idea, not obtained from existing charts, of the great difference existing in certain places between the absolute barometric height and the extreme variations of pressure, which may be great in one place and less at another point on the same barometric curve.

M. RENOU points out that M. Ritter's mode of notation presupposes a knowledge of extreme ranges (per barometer, or thermometer, etc.) which we may not have. Thus, the mean of barometric minima at Paris from a thirty years' record of observations is 732 millimeters; but in 1821 the barometer fell to 713.

M. RITTER replies that he eliminates exceptional extremes as well in one sense as in the other.

Rev. P. DECHEVRENS notes that he himself obtained in China a method of studying barometric variations similar to that of M. Ritter. His subject of study was the barometric variations of Asia. It is known that the mean pressure in Asia varies greatly from north to south; in a given month these differences may mask the presence of accidental depressions. But if we take for each station the mean monthly pressure and determine for a given hour of the day the difference between actual pressure and mean pressure, which can be traced on a general chart, the resulting curves of equal pressures and areas of low and high relative pressures will then be very evident. This method is especially useful because it does not require us to take into account the height of the station, nor even instrumental errors, if these only remain constant during the series of observations. Rev. P. Dechevrens published in 1882 thirty-odd charts, showing all the variations of pressure in Asia for the month of January of that year.

Rev. **PÈRE DENZA** presents to the congress several notes by members of Italian societies, as follows:

(1) Studies of Jean Alphonse Borelli on the atmospheric pressure, with notes by Italian authorities.

(2) Letters of Jean Alphonse Borelli to M. Malpighi and M. Magliabechi.

These papers and commentaries on them are of value for historic researches relating to the meteorology of the seventeenth century.

M. **L'ABBÉ MAZE** presents his proposed classification of clouds and especially their nomenclature in the binary form, analogous to that employed by botanists since the days of Linné. The binary method has the advantage of permitting us to multiply the names of clouds in any given class as much as we find it necessary, while keeping the number of class names within reasonable limits (see also record of proceedings of last Friday), which he suggests be fixed at eleven.

M. **HILDEBRANDSSON** says that, in proposing with Mr. Abercromby his method of classification, he wanted, not to form a new one, but only to modify Howard's classification and render it more useful. To obtain observations of any value it is indispensable that the memory of the observer should not be laden with a complicated nomenclature.

M. **L'ABBÉ MAZE** points out that all kinds of clouds can be recorded by his method and appropriately named, which is not the case by Howard's method.

A general discussion ensued on the subject of cloud nomenclature, participated in by MM. Teisserenc de Bort, Mascart, Rev. Père Dechevrens, and several others, the general sense of which seemed to be that the system of abbé Maze would be too complicated for use, except by scientific observers.

M. **TEISSERENC DE BORT** laid before the congress some photographs of lightning flashes taken by M. Weber, and showing that, in using improved apparatus, a band of light is obtained on the plate instead of the narrow thread of previous views. The inference drawn by M. Weber is that the duration of the flash is much more appreciable than has been supposed.

M. **PILTCHIKOFF** takes exception to this view, and inclines to the belief that the band shown on the photograph is due to the reflection or heat effect on the air, or both; that it is not the flash alone which is represented.

The congress hereupon adjourned, at 12.20 p. m., to meet at 9 a. m., September 24.

### MORNING SESSION.

TUESDAY, *September* 24, 1889.

M. CRULS in the chair.

Congress met at 9 a. m., and after reading the record of the previous day,

M. CORNU read a paper on the photopolarimeter for the polarization of light. The light enters the apparatus by a rectangular aperture, and is received on a Wollaston prism by which the rays are polarized at 90°. If in this apparatus the light from the sky is received, the two images will be of unequal brightness, which proves that the light is polarized. A Foucault "analyseur" is adapted to the instrument, and by turning it the two images can be made equal. The apparatus is so arranged as to measure the angle by which the analyseur had to be turned to get this result, which gives the proportion of polarized light by the formula.

$$\frac{p+9}{p-9}=\sin\ (w_2-w_1)$$

The apparatus is then turned 90° on its axis, and the observation repeated.

The use of the apparatus is very easy, and it requires no tripod or mount. As it is advantageous to observe that part of the heavens where the polarization is greatest—the point situated in the vertical plane of the sun and 90° from that orb—the observer turns his back to the sun and places himself so as to see on the ground the sun and the apparatus in its prolongation; the instrument is then inclined until the graduated circle perpendicular to the cylinder no longer throws a shadow. To determine afterward the position of the polarizer, the apparatus is turned about its axis until the maximum difference between the two images is obtained. Then the analyseur is turned, the operation being resumed after turning the instrument 90° about its axis.

An exactness to one one-hundreth can be relied upon. The polarization sometimes rises to 0.80. The apparatus verifies its own measurements, since it has been turned 90°, and consequently the sum of the angles $w_1$ and $w_2$ obtained must be approximately that figure.

The apparatus is sufficiently delicate to measure the polarization of light in the sky during the night at the approach of the full moon. For this purpose the aperture is enlarged and fitted with cross-wires (*gril*).

The proportion of polarized light is characteristic of the state of the sky. With clear sky and SW. wind we obtain 0.72 to 0.74; with the wind NE. the proportion decreases to 0.57 and 0.50. With fog or haze it falls rapidly to 0.

The most remarkable feature is the rapid variation of amount of light polarized corresponding to a great change of meteorologic conditions, and that, too, long before other atmospheric phenomena give any decided indications. It is therefore suggested that meteorologists study this instrument, which furnishes precise indications on a scale of 0–100, and not the vague data that one has to derive from the color of the sky or its more or less hazy (*brumeux*) condition.

M. HURION states that at the observatory of Puy de Dôme, M. Cornu's apparatus is already in use.

M. RAULIN communicates his memoir on the subject of rain districts. Evaporation follows a certain law, according to the seasons. Rain records give a similar curve, on taking means of five, ten, and twenty years. In continental (European) regions the curve follows the same general tracing as that of temperatures. Along coast lines, however, we first find the quantity of winter rains on the increase, then those of the autumn, so that the curve takes a form almost the reverse of the temperature curves. Near the Mediterranean its form is somewhat different: there is a continuous increase from winter to autumn. Getting nearer still to the coast there is a decrease of summer rains and an increase of winter rains. In the plains of Gascony and of the Po there is a considerable increase (and rise of curve) for the spring rains.

M. RAULIN shows maps of Europe, France, and of the Cape of Good Hope, where he has marked by different tints the regions to which the different curves apply.

M. DE MONTESSUS reads a memoir on the subject of earthquakes and their alleged relation with lunar culminations. He has collected data concerning some 45,000 earthquakes, occurring at all points of the globe, and classed them in six series, in the order of their magnitude.

The general relation between day and night observations is about 0.75 to 0.25, which seems to bear out the generally accepted opinion.

But a critical examination shows that the 0.75 approaches unity, as the intensity of the shock increases; for instance, for the intensities of 9 and 10. For the intensity of 4, the ratio descends to 0.40. Moreover, there is a small maximum of ratio at about midnight, followed by a maximum at 4 a. m. He therefore attributes the difference between number of day and night observations to physiological reasons. At night the quiet and the horizontal position make us more sensitive to oscillations, which could pass unperceived during the day. The minimum at about midnight he sets down to the soundness of first sleep.

For the times of meridian passages of the moon, Perret has noted a maximum of 0.06. But this maximum is not general, and in one hundred and two series it is only found in four or five.

As to the sun, its effect is said to be even less than that of the moon. The speaker has not yet made any researches on this influence, but hopes to do this.

An objection to his views might be made on the ground that there could be a retardation such as we observe in the moon's effect on tides. But that argument is easily refuted, for the maxima of earthquake effects observed are shown by his figures to have no regular time interval separating them from lunar meridian passages.

**M. Gossot** believes he has noticed that earthquakes are more intense at the time of the conjunction of some planets, but that is simply a hypothesis which requires confirmation. When volcanoes act normally, however, there are few earthquakes. When their action is unusual, there are more.

**M. Wada** notes that the Japanese observations lead to totally different conclusions from those of M. de Montessus. M. Wada's observations, covering a period of more than ten years, prove that earthquakes are more frequent by day than by night. Observations from 1876 to 1886, at Tokio, show that there is a maximum between 8 and 9 p. m., and a minimum from 11 a. m. to noon. The observations of the whole empire in 1885 and 1886 show a maximum between 10 and 11 p. m., and a minimum between 10 and 11 a. m.

As to relations with the phases of the moon, M. Wada finds more records of earthquake in the interval from last quarter to new moon than in other quarters, but the numbers differ very little.

Rev. Père **Ferrari** has observed earthquakes in the Philippine Islands. He has noted no coincidence with lunar phenomena or phases, but an increase during low pressures.

**M. De Montessus** insists upon his view as correct. As to the effect of pressure, the comparison of some nine thousand observations has revealed no such relation. Earthquakes do not depend in any way upon meteorologic conditions.

**M. Teisserenc de Bort** thinks that, so far as possible effect of pressure is concerned, one should take only records of places where the barometer is subject to reasonable fluctuations, and not places where it is substantially steady all the year around.

**M. Raulin** notes that the French observations differ from those of Japan. In that country earthquakes are more frequent in newer geologic formations, and here in older ones.

**M. Mascart** notes that there are certain relations which appear so natural that they are often accepted as laws without sufficient reason. He cites the case of fire-damp in mines, which is so universally associated with low pressures. M. de Chatelin made a study of records on this subject and found that the alleged relationship had not the slightest foundation.

**M. Ritter**, from numerous observations made in Asia Minor, notes a frequent coincidence between severe storms and the occurrence of earthquakes. He adds that, locally, the natives often find in the appearance of the sky reasons for successfully predicting earthquakes.

Rev. Père **Ferrari** thinks that in records of earthquake shocks volcanic regions should not be grouped with others; there may be special causes for the movement in the former case.

**M. Angot** presents a report (synopsis) on the observation of phenomena in vegetation, on the migration of birds, and appearance of insects. The report will be printed in full for distribution. M. Angot merely calls attention of the congress to the necessity for a large number of stations in order to eliminate local influences. One must also choose but a few species of animal and vegetable life to observe and report upon, and these should be easy to recognize and cover a large field of observation; the list of phenomena observed should also be short.

The methods of recording should also be carefully selected. M. Angot begs that meteorologists may examine these different points and give him the benefit of their advice and experience.

M. **Teisserenc de Bort** reads a communication from M. de Touchimbert on the quantity of heat necessary for the maturing (*maturité*) of wheat. The observations were made in the neighborhood of Poitiers at an altitude of 115 meters. The question was raised originally by Réaumur. Bouningeault had given the figure of 2,000° from planting to vegetation, from the time when the temperature exceeded 5°. Gasparini gave 1,601° for Olange and 1,744° for Paris.

It is difficult to determine the precise moment from which the record should begin. For autumn wheat there are differences due to the quality of soil, their exposure, etc. M. de Touchimbert prefers to count from the renewal of vegetation, in leaving out all temperatures lower than 6°. On this basis he determined for a mean of ten years a temperature of 1,885°, with a sheltered thermometer. There is between the maximum and minimum a difference of 287°, or one-ninth.

It is, moreover, evident that the thermometer and plant are not under identical conditions. He tried to obtain, in addition to the above record, reliable data from a second thermometer, suspended in the open air (unprotected) and just clear of contact with a grassy soil. This gave a mean of 2,469°, showing a difference between extremes of 101°, or one-twentieth.

He believes, however, that this method really approaches more nearly to what actually occurs with the plant.

M. **Angot** asks if M. de Touchimbert's conditions of observation are well defined; wants to know, especially, the height of the thermometer above the grass; fears that the bulb may get coated with mud and so vitiate the results. It is absolutely necessary that all conditions should be exact in such experiments.

M. **Renou** says that they avoid the effect of spattering on the bulbs at St. Maur by uniformly painting them with green. He says that he observed on the 17th of this month a minimum above ground of + 1°.1 while the thermometer under ground stood at — 5°.4. This cold had no effect on beans, while dahlias and other flowers were affected.

M. **Mascart** notes that beans did not suffer from the late cold on the plateaus, but that they did on the hill-sides, owing to the descent of cold air strata toward the lower beds.

M. **Hildebrandsson** notes the great difficulty of getting exact sums of temperatures, especially if the plants observed are at the limits (north or south) of their zone of cultivation. When a plant is near such limits it needs a much higher total of heat degrees to develop it. Therefore no general law of temperatures for a given plant-life will hold good throughout its whole zone of cultivation.

M. **ANGOT** agrees with M. Hildebrandsson, and thinks it is not only a question of how many heat degrees a plant receives, but also as to the scale on which the heat is imparted, which influences the result.

M. **l'ABBÉ MAZE** thinks that the degree of the thermometric scale is of importance chiefly to bring about the blossom, and the sum of heat-quantities for the development of fruit.

M. le doctor **FINES** presents to the congress his memoir on climate of Perpignan.

M. **SIEUR** presents a memoir on the direction of storms in the southwestern part of France. This general direction is from southwest to northeast. Some storms have a direction from west to east, and at rare intervals there are storms from east and from northeast. He considers the last as local; the first, however, côme from the Bay of Biscay and have a wide extent. M. Sieur dwells on the influence of valleys and water-courses on the direction of storms, which he says they tend to follow.

M. **GOSSOT** thinks that the track of storms is influenced by the direction of water-courses. He makes also some remarks about the prediction of storms from the conjunction of planets.

M. **TEISSERENC DE BORT**, in reply to a question, says that the Bureau Central Météorologique compiles all the general storm observations, but can not enter into the discussion of local disturbances, which there is great interest in having discussed and studied by the local societies themselves.

Lieutenant **WARD**, U. S. Navy, presents to the congress a series of maps and books published by the Hydrographic Office, Navy Department, and dwells upon the necessity of international co-operation in meteorologic observations. (See appendix.)

M. **RENOU**, having expressed the thanks of the congress for the information laid before it, the congress adjourned at 12.30 to meet at 2.30 p. m.

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## AFTERNOON SESSION.

TUESDAY, *September* 24, 1889.

The Congress met at 2.30 p. m.

The secretary presented a memoir by M. Ellis, being a general review of the existing magnetic instruments (to be printed and distributed later).

In addition the following papers were read, many by title only:

Flood warnings on the Loire, by M. Mazoyer.

On comparative values of different forms of anemometers, by Dr. Fines. A long discussion took place over this paper between Dr. Fines,

M. Ritter, M. Richard, and others, as to the relative merits of the Bourdon and later principles. The general sense of the discussion was unfavorable to the Bourdon.

Memoir on thermometer exposure and thermometer shelters, by M. Renou (to be printed).

Measure of relative humidity, by Dufour, presenting two new forms of condensation hygrometers. (To be printed.) M. Renou took occasion to condemn the hair hygrometer.

Memoir by M. Gossot on the influences of weather on human beings, commented upon by Dr. Fines and others. The beneficial effect of compressed air on the human system was referred to, instances quoted from its effect on workmen in caissons, etc., under pressure.

Memoir by M. Teisserenc de Bort on the distribution of pressures on the earth's surface. One or two plates were missing from the copy of this pamphlet as first published, so that it was not generally distributed; a new edition will be prepared.

Memoir on the climate of the Argentine Republic, by Mr. G. Davis.

Memoir on optical phenomena of the atmosphere, by M. Cornu.

M. Teisserenc de Bort's pamphlet on the meteorologic telegrams from the United States; presented for reference.

Congress adjourned at 5 p. m., to meet Wednesday, 2 p. m., after accepting an invitation to ascend the Eiffel tower on Wednesday morning.

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WEDNESDAY, *September* 25, 1889.

M. BILLWILLER in the chair.

Congress met at 2 p. m. The record of the previous day having been read—

M. PILTCHIKOFF presents a note on magnetic anomalies. To determine their cause, the author has studied the correlations between the perturbing magnetic masses and the deformation of isomagnetic curves. He has not attempted to formulate a theory of magnetic anomalies, but has studied only the question of anomalies produced on the earth's surface by a magnetic mass at the interior; he develops a geometric method which permits one to determine easily the various isomagnetic lines. (To be printed.)

M. TEISSERENC DE BORT says that M. Piltchikoff's method will enable us to find the cause of certain anomalies which have not yet been explained. He thinks that a distinction should be observed between deviations of the telluric currents and perturbations due to the special character of the ground. Thus in Algeria, in the mountainous regions north of the Sahara desert, he has found anomalies at points which did not seem to be subject to a magnetic influence, properly so called.

M. MOUREAUX adds that he has found by repeated observations made at different points in the neighborhood of Paris, to the westward, that the plateau of Beance has a special influence on the magnetic needle not explained nor accounted for by the nature of the ground.

Rev. Père **Denza** says that local influences are very frequent. He has observed at Turin at six different points and obtained as many different sets of values. When the stations are very distant it is difficult to note these anomalies, which only become apparent as we increase the points of observation. It is the same with magnetism as with other observations—deviations have been observed, and their cause is to be found in the discontinuity of the earth's mass (*la discontinuité de la masse terrestre*).

M. **Gossot** says that one should compare the magnetic perturbations with the relative positions of the sun and planets.

M. **Piltchikoff** answers that this hypothesis is inadmissible after the hypothesis of Gauss, which is conclusive. Moreover, M. Mascart has shown that to explain in any such way the diurnal variations of declinations and horizontal component, it would be necessary to attribute to the sun a magnetic moment greater than that of tempered steel.

M. **Mascart** adds that it has already been attempted to establish relations between the position of planets and magnetic phenomena. Such relations are purely imaginary, and are so considered at the present time by all meteorologists.

M. **David** presents a memoir on the use of semaphores for agricultural weather warnings. The meteorologic dispatches from the Bureau Central rarely reach their destinations till 2 p. m. or later, by which time the farmers are in their fields. The meteorologic commission of l'Yonne has adopted a signal ball to be hoisted on a spar pole at any one of three positions, easily distinguishable at a distance and each position conveying a different meaning to the husbandman.

The principle has been extended to several points in the Département de l'Yonne with valuable results.

M. **Hildebrandsson** notes with pleasure the efforts made in France to supply weather indications. In Sweden the method is as follows: One hundred and fourteen typical weather maps, each with a special number, are distributed (as a set) in the ports and railway stations. To indicate the weather probabilities, the Meteorologic Bureau has only to telegraph to all stations the map number corresponding to the conditions predicted. On receipt of this information the proper signals are made at the railway stations and in the harbors.

M. **Billwiller** says that the method is excellent, but the variations from day to day are so numerous that it must require an experienced person to interpret the signals properly.

M. **Poincaré** gives the general conclusions of his paper on the influence of the moon's declination upon the changes of zone of the trade winds. He gives details of the barometric movement at latitude 30° and at latitude 10°, points out barometric changes of 0.50 to 1 millimeter which occur at the passages of the moon at perigee and apogee, and which, as they are not simultaneous at 30° and at 10°, produce in the barometric gradient a sudden movement (*un ressaut ou une chute brusque*). The southern equi-declinations produce a slight rise at 30° and a slight fall at 10°; the northern equi-declinations produce a fall of about 0.30 millimeters at 30°, and a rise of about the same amount at 10°. In winter, at full moon, a rise that may equal 0.50 millimeters at 30° and a little less at 10°; at new moon, a very slight fall on both parallels of latitude. In summer there is no marked effect.

M. **Billwiller** presents a note on the diurnal variation of the force of the wind at different heights. It has been found by comparing a large series of observations made on the level that there was an average maximum everywhere between 1 and 2 p. m. and a minimum before sunrise. The amplitude of oscillations is greatest for dry easterly winds and least for damp winds from west. He has also found that at mountain stations the curve of variations was substantially the reverse of the curves of observations on the level. Observations made on the Sentis in 1883 confirm this view. This result is explained by M. Köppen by attributing it to the ascending and descending air currents, under the influence of changes of temperature. It must be noted, however, that M. Espy, without knowing the diurnal periodicity of winds in the upper strata, had also pointed out the way to this theory.

By the same explanation we can account for the curves of force of wind obtained by M. Angot at the Eiffel tower and already communicated to this meeting.

M. **Lasne** resumes the theories that he has already presented to the Meterologic Society on the formation of atmospheric disturbances—revolving storms.

M. **Teissereno de Bort** thinks it necessary to distinguish between barometric depressions which are due to the appearance of zones of low pressure and those which are due to the influence of heat on the soil, as he has shown in his study of the Iberian Peninsula.

M. **Poincaré** indorses this view.

M. **Hildebrandsson** states that it is difficult to distinguish between two sorts of movement and their causes, when combined. He quotes facts to show how impracticable it is to formulate a theory for the formation of revolving storms which will be of general application.

Mr. **Lasne** replies that he does not profess to offer a complete solution, but simply endeavors to take a step forward in the study of the manner in which revolving storms are formed. He does not consider it a good reason to neglect the study of a phenomenon because it is complex, or because of the probability that no perfect solution is obtainable.

The Rev. P. **Dechevrens** presents a memoir on observations of the inclination and vertical component of the force of the wind. He describes the various apparatus used by him to measure the vertical component at the observatory of Zi-ka-wei, China.

He compares the inclination of the wind with the barometric height and shows that, according to his observations, the motion of the air is upward during barometric depressions.

He notes that the curve of mean variation of the inclination of the wind at Zi-ka-wei for 1886 is precisely the contrary of the curve of variation of atmospheric electricity obtained by Dr. Fines at Perpignan.

Cup anemometers give neither the vertical component nor force of the wind with exactness.

Rev. P. **DECHEVRENS** proposes to replace the hemispheres by hemi-cylinders on which the vertical component can have no effect when measuring wind force. In any case there must be a radical improvement in the forms of apparatus generally used for measuring wind force.

The Congress adjourned at 6.30 p. m., to meet Thursday at 9 a. m., in supplementary session.

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## MORNING SESSION.

THURSDAY, *September* 26, 1889.

The Congress met at 9 a. m.; M. le Capitaine **PUJAZON** in the chair.

Mr. **RAULIN** commented on the Argentine notes on climates by Mr. Davis to show that his (Raulin's) previous remarks about distribution of rain-fall applied exactly to the Argentine Republic, as they had to other countries.

The Secretary announced the unavoidable absence of the President, Mr. Renou, detained by illness.

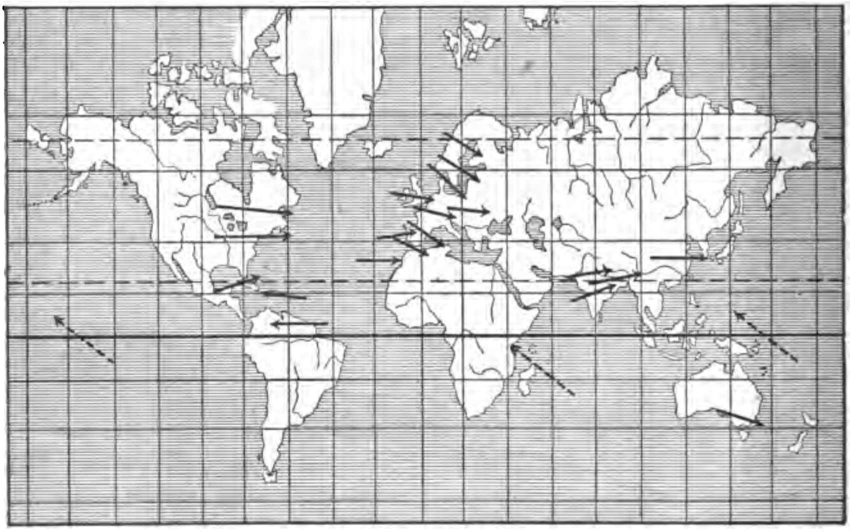
Mr. **WADA** presented a list of observations on thunder storms, made in Japan. He also submitted a proposition that the Congress should adopt a resolution recommending a uniform system of storm signals for adoption by international consent. He submitted in connection with this resolution a combination of signals, where globes and cones are used by day and colored lanterns by night, to convey the storm warnings.

M. **MASCART** proposed that M. Wada's resolution be so far modified as to leave the actual selection of signals to some future time. The proposition, as amended, was approved by a vote of the Congress.

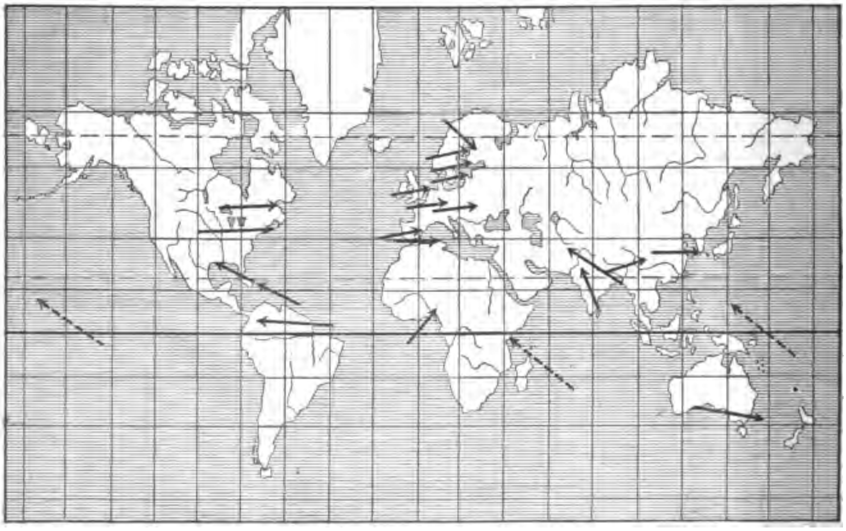
Rev. P. **DENZA** presented a memoir by the Rev. P. Bertelli on earthquake observations at Florence.

M. **HILDEBRANDSSON** then read a very long paper (to be printed) on the mean direction of the cirrus and upper currents of the air. The mean direction of the wind for a large number of stations has long been known, but much information remains to be obtained on the upper currents.

For Europe we have a series of data with the result that the mean drift of the cirrus is from points between northwest and southwest at all European stations and at all seasons, but in winter they move from



Mean direction of motion of cirrus clouds—winter.



Mean direction of motion of cirrus clouds—summer.

a more northerly direction than in summer; this is especially true of Sweden and of the northern coast of the Mediterranean.

For Canada the mean direction of the upper strata is from W. 8° N.

In the United States at Blue Hill, according to Mr. Clayton, the mean direction is almost invariably from west.

At Zi-ka-wei, China, same.

At the top of the peak of Teneriffe the wind is from southwest, while it is from northeast at the bottom. Hence for the upper currents, on the theory of superposition of winds as developed by Mr. Hildebrandsson in 1877 (published in Atlas des mouvements supérieurs de l'atmosphère, Stockholm, 1877, p. 14), the direction must be very nearly from west.

From the southern temperate zone we have only the observations of Neumayer, Melbourne, March, 1858, to February, 1859. The upper current is constant, from W. 16° N.

The general results are:

That in temperate zones the upper currents move from west to east.

That in the tropics the reverse obtains.

The direction of the upper currents seems to coincide everywhere with the mean trajectory of the centers of barometric depressions.

Professor Loomis, in his study on the atmosphere, has concluded that the whole great system of atmospheric circulation is the chief cause of the trajectory or displacement of cyclones. The facts that M. Hildebrandsson has just announced "confirm the conclusions of this illustrious savant, of whose recent death he has heard with great regret."

*Table—Upper Currents.*

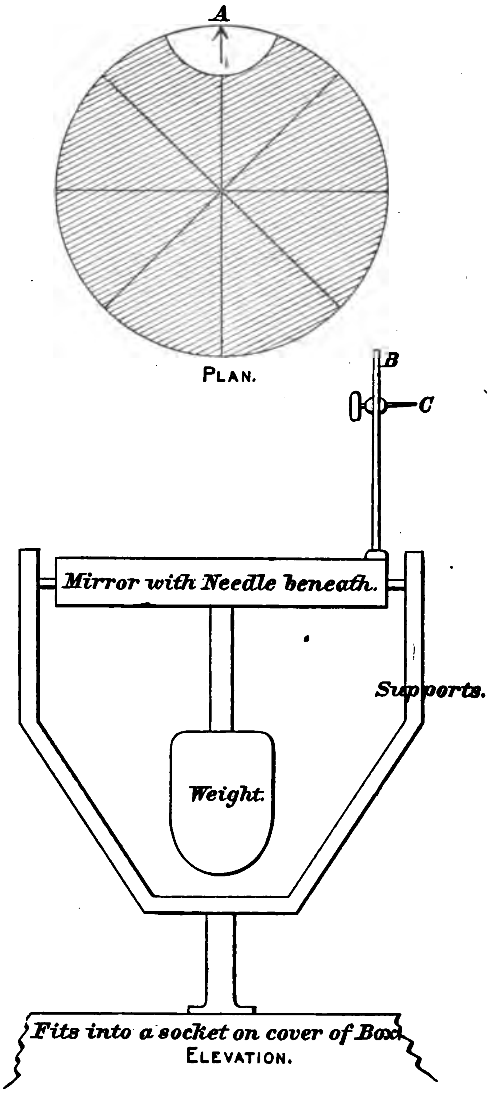
| | Winter. | Spring. | Summer. | Autumn. |
|---|---|---|---|---|
| | *From—* | *From—* | *From—* | *From—* |
| Canada | W. 8° N. | W. 14° N. | W. 3° S. | W. 12° N. |
| Zi-ka-wei | W. 5° S. | W. 3° S. | W. 6° S. | W. 5° S. |
| Paramaribo | E. | E. 1° S. | E. 12° S. | E. 1° N. |
| Assam | W. 6° S. | W. 10° S. | W. 13° S. | W. 17° S. |
| Lahore-Calcutta | W. 8° S. | W. 36° S. | E. 36° S. | E. 7° S. |
| Kurrachee-Cuttack | W. 12° S. | W. 17° S. | E. 8° S. | E. 5° N. |
| Antilles | E. 7° S. | E. 29° S. | E. 30° S. | E. 14° S. |
| Havana | W. 15° S. | W. 21° S. | E. 26° S. | N. 31° W. |

Melbourne, October to March, W. 16° N.; April to September, W. 16° N.
Ocean, between tropic of Cancer and 15° S., E. 31° S.

M. **Hildebrandsson** then submitted to the Congress a nephoscope for use at sea, invented by Dr. G. Fineman and made by M. Rose, of Upsala. Price, about 75 francs.

It consists of a polished (dark) mirror about 3 inches in diameter, set above a compass needle which is visible through a clear space left at A, the rest of the mirror surface being black. An upright rod B is provided for sighting, and bears an adjustable arm C.

With this little instrument, which is portable and sufficiently accurate for the purpose, M. Hildebrandsson has made a large number of observations in connection with Dr. Fineman.


A
B
C
Mirror with Needle beneath.
Supports.
Weight.
Fits into a socket on cover of Box.

PLAN.

ELEVATION.

FINEMAN'S NEPHOSCOPE.

M. TEISSERENC DE BORT announced the preparation of a paper by M. Renou on the necessity of obtaining uniform data as to fog, rain, etc. The existing methods of recording these phenomena are too vague and differ too radically. M. Renou's suggestions for a uniform nomenclature and mode of observation will be printed.

M. **Lasne** desired to state, in connection with Rev. P. Dechevrens' paper of yesterday, that he did not think an ascending current amounting to a vertical component of notable force could be observed at the altitude of 40 meters. He thought that the observations had been subjected to some constant error, due to possible imperfection of instrument or its location; or else, since it requires a certain amount of force to cause the anemometer to move at all, that in the ascending and decending movement of air the ascending puffs were relatively short and violent, the descending motion being easier and taking longer, and that the instrument would record the former and not the latter. His reference to ascending and descending air-motion was based on his view that the wind in moving along a level surface had, at contact with the ground, a sort of turning motion imparted to it, like that of a wheel moving on a road. The upward motion in such case could very well exceed in violence the slower descending movement.

Rev. P. **Dechevrens** defended his deductions, and M. Teisserenc de Bort agreed with M. Lasne as to the improbability of obtaining a marked vertical component at only 40 meters from the ground.

After some remarks by M. Richard on the comparative values of the different anemometers, in which he spoke favorably of the Robinson (condemned by the Rev. P. Dechevrens) and also described some of his new apparatus for registering wind pressure (see pamphlet on barograph, pp. 33–43), the congress took a recess until 3 p. m.

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## CLOSING SESSION.

Thursday, *September* 26, 1889.

Rev. P. **Denza** in the chair.

Memoirs were submitted as follows:

Dr. **Fines** presented a paper on atmospheric magnetism, and made some remarks as to the precautions necessary to be taken with the instruments used for these observations. His observations were made at Perpignan. Only those of normally fair days were considered; of such there averaged some 217 in the 365. His values show a maximum of magnetic intensity in January, a decrease to April; then the curve becomes practically a straight line till September, rises till November, and stays high till January. The fact that it is getting to be, respectively, warm and cold later in the year will affect, in his opinion, the times of the maxima and minima.

M. **Mascart** believes that the whole subject of magnetic condition of atmosphere is of the greatest interest. He thinks that its variation is due to very complex causes, and thinks that much depends on the "topography of the instrument." Objects even at a great distance can affect the result. He thinks that vapor and the absorption and breathing, even, of vegetation cause electric disturbance; or that where the wind has passed over a neighboring forest it can modify the magnetic conditions. He makes these suggestions because he considers the subject new and of great interest. He thinks that neglect of these and like considerations impairs the value of all the older observations, no matter how faithfully taken and recorded.

M. TEISSERENC DE BORT announced the receipt from Mme. la Baronne de Pape of a series of articles on the meteorologic work of Philippe Girard. He made the first meteorograph, in 1829, for an observatory at Warsaw, where it is still serviceable, recording barometer, thermometer, rain-fall, etc. Many ideas adopted in modern instruments owe their origin to his.

M. DE BORT also presented a paper by M. Piche on the circulation of the atmosphere. The writer thinks that this takes place in inverse ratio to the energy of animal and vegetable growth. M. de Bort notes two objections to the writer's views and conclusions: (1) It would be impossible to change the general conditions of vegetation on the globe. (2) If we could succeed in reducing the temperature of equatorial regions, that of the polar zones would decrease also and reduce vegetable life at those extremities.

Rev. Père RAOLOT presented, by title, a paper on the relation between force of wind and barometric gradients.

M. CRULS mentioned a climatologic dictionary that he had in course of publication.

Mr. ROTCH presented a paper by Mr. Clayton, of Blue Hill Observatory, on the study and classification of clouds. Of the two methods of classifying clouds, by origin, or by form, the writer proposes classification by form.

M. MOUREAUX presented his "Études magnétiques," being work done under the direction of the Bureau Central Météorologique.

[This is considered some of the best work brought before the congress. On account of the time devoted to a long discussion between Rev. Père Ferrari, M. M. Denza, Hildebrandsson, Dechevrens, Fines, etc., on the old question of effect of forests on rain, M. Moureaux had to make his explanations very short.—W.]

M. MASCART expressed his thanks for the invaluable services of M. Moureaux and paid him a very high tribute for the character of his work, in which France had taken the lead. Several other members expressed similar opinions.

Rev. Père DENZA introduced a paper on the relation between magnetic perturbations and earthquake effects in Liguria.

M. TEISSERENC DE BORT announced his publication in the minutes, hereafter, of a paper on reduction of barometer readings to sea level. On behalf of M. Renou he offered a resolution, which was unanimously carried, to the effect that the Congress recommended a study of means "for securing uniformity of observations of fogs and rains."

M. MASCART wished to have a parting shot at the much-vexed forest question. The truth seemed to be conceded that forests, by playing the part of immense natural sponges, absorbing the moisture slowly and giving it forth slowly, were of decided effect on the surrounding country, but only to that extent. He also made a humorous allusion to his regret at the disappearance from Algeria of the best of *gardes-forestiers*—the lion. As that animal has disappeared the sheep have worked in and made havoc with the young tree growth.

The hour of adjournment having arrived, M. Mascart expressed his regret at the absence of M. Renou; the latter had delegated M. Mascart to thank all present for their attendance, but particularly the foreign members who had gathered from every quarter of the globe to attend this Congress. M. Mascart was glad to find here not only representatives of great nations, or of renowned observatories, but such a large proportion of independent observers, also. If there is any one thing more needed than another in metereologic work, it is the "*bonne volonté*" which is exemplified in the work of the latter class of observers.

The Rev. Père DENZA thanked M. Mascart in behalf of the foreigners. In coming here to attend a congress for the advancement of the science of meteorology, and of the sister branch of astronomy, we have been in a position either to get very far away from the *petites misères* of the world, or to rise very far above them. This has been one reason for the pleasant feeling that has marked these sessions, We have been to China with the Rev. Père Dechevrens, to Japan with M. Wada, at sea with the sailors, in the Alps with Rev. Père Ferrari. in the clouds with Hildebrandsson, and to the sun and planets with other observers, but have always been able to return from these excursions without fatigue or bad feeling of any kind. He wishes for the results of the Congress all possible success, and to the individual members, happiness. He sends, on behalf of the whole assembly, a greeting to the absent president, M. Renou, and at 6.15 p. m. declares the International Meteorologic Congress of Paris, 1889, adjourned *sine die.*

All of which is respectfully submitted.

AARON WARD,
*Lieutenant, U. S. Navy,*
*Representing U. S. Navy Department at Meteorologic Congress.*

# APPENDIX.

## MARINE METEOROLOGY, HYDROGRAPHIC OFFICE, U. S. NAVY.

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*Address by the American Delegate, Session of September 24.*

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In presenting these examples of the meteorologic work of the American Hydrographic Office, I only seek to second the declaration of our honorable president, in his opening discourse, upon the necessity of international meteorologic co-operation.

Among the charts and books which I have the honor to present to the Bureau in the name of the Secretary of the Navy of the United States, I would call the attention of the congress to the Pilot Charts of the North Atlantic Ocean, published each month by the U. S. Hydrographic Office and distributed gratuitously in all our large sea-ports and to certain foreign consulates. A special manuscript chart indicates the method adopted in order to classify and separate the daily reports, in order to combine them at the end of the month in the general chart.

Among the forms, some of which relate to the subject of special phenomena, I would recommend to the attention of the congress the printed blanks for daily observations; these the Hydrographic Office distributes to all ship-masters who ask for them, and of whom we are happy to count actually more than 1,050 regular observers, in addition to the U. S. Navy. As indicated in the preface of these forms, the Hydrographic Office will willingly adopt any proposition that will add to their usefulness. The return of these reports can be made gratuitously in the United States, and even from foreign countries by means of the consuls or the captains of United States men-of-war.

The office, through its branches in the large sea-ports of our country, furnishes the means of comparing instruments, barometers, thermometers, and chronometers, for the purpose of obtaining the most accurate observations possible.

The object aimed at by our Secretary in establishing these branch offices and distributing these publications is evident. The ocean covers the greater part of the globe. The men who pass their lives in the navigation of the seas are the only ones who can regularly furnish us with the most precise information upon the meteorology of remote latitudes, save when a Dumont d'Urville, a Nordenskjöld, or an Abercromby comes amongst us to inscribe his name in letters of gold on the pages of the book of science.

The mariner is not more egotistic than any one else, but it is certain that we can only be assured of his indispensable co-operation when we, on our part, furnish him with results of some practical value. For this it does not suffice that only one nation bear the expense, in money and intelligence: it is important to secure the most intimate co-operation between all nations and the most cordial and liberal interchange of scientific ideas. Even those countries that have no sea-coast can lend very appreciable assistance, and profit by the information obtained.

This is why, without occupying your attention too long upon the methods that we have employed, I restrict myself to presenting to you the following declaration on the part of the Secretary of the Navy, whom I have the honor to represent. I am authorized to say that the Secretary is ready to receive, publish, and distribute at the proper time all meteorologic information that may be addressed to him, and that he will endeavor to issue this information in a way useful to the navigator as well as to the scientific meteorologist. The Hydrographic Office likewise is prepared to furnish the results of such observations to any other bureau or individual observer that may desire to profit by its co-operation. The Secretary of the Navy will regret greatly if the excellent system of simultaneous observations, organized by the Congress of Vienna in 1873, is to be abandoned at the very time when the results demonstrate its value to marine meteorology.

The synoptic charts that I present to you cover the ocean to the northward of the equator. The Hydrographic Office intends to undertake the publication of similar charts for the Southern Ocean. In order to accomplish this successfully a hearty co-operation is necessary, which the voice of this congress can do much to assure. And as a special subject I wish finally to solicit from the national representatives present the information that they may have received on the subject of the cyclone in the Pacific Ocean, in the month of March last, which destroyed the American and German squadrons in Samoan waters. A report is preparing on this subject

It only remains to me to thank you, gentlemen, for the attention that you have kindly given to me, and to second the ideas of your minister of marine by these words borrowed from a distinguished meteorologist: In science one can always hope that "The Utopia of to-day may become the accomplished fact of to-morrow."

AARON WARD,
*Naval Attaché, United States Delegate to the International Meteorologic Congress.*

PARIS, *September* 24, 1889.